# Q's and A's for Ecological Impacts
**(5/11/2010 Eco Impacts Team)**

## Outline

- General Questions
- Biological Impacts
- Threatened and Endangered Species Impacts
- Wetland Impacts

## General Questions

**Q: What are the ecological effects of the oil spill?**

**Short Answer:** The oil will affect ecological resources through toxicity (primarily the aromatic, volatile components of the oil), coating of plants and animals, and through direct ingestion of the oil sheen, mousse (oil/water mixture), or tar balls. The potential impacts may be greater given the particular season in which this spill is occurring. Many of the animals along the Gulf Coast, including fish and birds, are spawning and reproducing at this time. Coastal wetlands in Louisiana and Mississippi provide the critical breeding grounds and nurseries for 90% of marine species in the Gulf of Mexico.

**Detailed Answer:** The most immediate affect is in the offshore waters. The oil would come in contact with the microscopic plankton (which are tiny plants, known as phytoplankton and small animals including eggs and larvae of fish and macroinvertebrates, called zooplankton) in the surface waters, and fish, turtles, and marine mammals. The plankton form the base of the food web that supports marine species. Any impacts on this food base may affect the entire marine ecosystem.

Breeding season brings fish and other aquatic animals (sea turtles, birds, etc.) into shallow water, increasing the potential risk to them. It also makes shoreline associated birds and other wildlife less likely to flee the oncoming oil, given their desire to maintain the reproductive seasonal territory many have just claimed.

We are already seeing impacts on marine turtles which may think the oil is food and ingest the tar balls. The Mississippi barrier islands and Chandeleur barrier islands are major nesting and breeding areas for sea turtles. Endangered and threatened species that could be impacted include the West Indian manatee, five baleen whales (the northern right, blue, fin, sei,and humpback), one toothed whale (the sperm whale), Gulf Sturgeon, Smalltooth Sawfish, Dusky, Night and Tiger Sharks, Nassau and Warsaw Grouper, and five species of sea turtles (the Green, Hawksbill, Kemp's Ridley, Leatherback, and Loggerhead).

**Q: How will the oil spill affect marine organisms?**

**Short Answer:** The toxicity of petroleum on marine organisms is dependent upon the concentration and composition of its individual hydrocarbons at the time of impact. Since most oils float, the creatures most affected by oil are animals like sea otters and seabirds that are found on the sea surface, or on the surface of beaches if the oil comes ashore. During most oil spills, seabirds are harmed and killed in greater numbers than other kinds of creatures.

**Detailed Answer:** The relative impact of the oil will shift as spilled oil weathers due to the change in its chemical composition. Because the oil is being released such a distance from shore and at such depth, it is anticipated that the oil will undergo significant weathering before reaching shoreline areas. Sea conditions will weather the oil, as the more water soluble compounds tend to be "extracted" from the oil, leaving the less soluble and more viscous compounds to continue to coalesce on the water surface. The more viscous nature of the oil can have deleterious effects by causing coating of marine organisms and the tar balls that form may be mistaken for food.

The use of dispersants offshore will lessen the potential impact of the oil onshore, however it may increase the risk for water column toxicity in the areas where the dispersants are being used. Generally, dispersants are used in deeper waters, which allow aquatic life the opportunity to flee from the plume of dispersed compounds. Using dispersants in shallow water can exacerbate some of the aquatic toxicity of the spilled oil (e.g., it solubilizes chemicals contained in the oil) and therefore they are not often recommended for use in shallow waters.

**Q: What would be most affected by the oil spill along shorelines, bays, and estuaries?**

**Short Answer:** It is anticipated that the majority of the negative impacts of the oil as it approaches the shore and makes landfall will be the physical effects of the oil on the plants, animals, and nursery grounds (wetlands, marshes and mangroves) with which it comes into contact. The oil could coat the marsh plants and estuarine organisms and may be toxic if there are any aromatic compounds that haven't evaporated and are still in the oil. The degree of impact will be highly dependent upon the type of shoreline that is affected.

**Detailed Answer:** These bays and estuaries are the nursery grounds for numerous fish and shrimp species. In fact, 90% of the marine fish and shellfish are estuarine-dependent. The greatest concern is for these critical shallow water habitats. Also among the most significant potential impacts from the spilled oil as it travels toward shore will continue to be the potential for oiling of marine mammals and seabirds as long as the oil is being released. *Wetlands and marshes* are fairly fragile and very biologically active habitats, therefore the physical effects of fouling and coating of these environments are also expected to be significant. Much of the aforementioned shorelines, especially for Louisiana, Mississippi and Alabama, contain these types of habitats. *Marshes* are great nursery areas for larval and juvenile fish and other aquatic organisms, as they provide cover and food resources. If substantial areas of the coastal marshes are severely altered or impaired by the oil, this could have significant and long term effects on the populations of the fish, shrimp and related animals that use these areas. *Mangrove* roots are exposed to obtain oxygen, and when they are coated with oil the plants

generally do not survive. It is not known how much of the shorelines of Louisiana, Mississippi, Alabama and the panhandle of Florida contain mangroves, but these are usually very productive and highly valued ecosystems. Petroleum and its by-products may injure and kill mangroves in a variety of ways. Crude oil coats roots, rhizomes, and pneumatophores and disrupts oxygen transport to underground roots. As with other intertidal communities, many of the invertebrates, fishes, and plants associated with the mangrove community are highly susceptible to petroleum products.

The spill may impact the brown shrimp (shrimp is the most valuable commercial species in the Gulf). They spawn on the bottom of the offshore waters. Their larvae then float to the surface and move into the marshes, which serve as a nursery until they get big enough to go back to their offshore bottom habitat. Currently, they are in the post-larval stage and beginning to enter the marsh nurseries.

Another significant impact is on the birds (see Marine and Coastal Birds Q & A). This spill is occurring at the height of the nesting season for many marsh and wading birds. The birds would be impacted by ingesting the tar balls mistaking them for food, getting coated with oil and eating oil contaminated fish.

The oil could also impact oysters which are currently spawning. Oysters also filter large volumes of water increasing exposure to the oil. The oil could persist in the marsh and open water sediments and impact aquatic organisms for quite some time.

Endangered and threatened species along the shorelines, bays, and estuaries include the inflated heelsplitter, bald eagle, piping plover, and West Indian manatee (see Threatened and Endangered Species Q & A).

**Q: What are some long-term effects of oil spills?**

**Short Answer:** Oil remains in the environment long after a spill event, especially in areas sheltered from weathering processes, such as the subsurface sediments under gravel shorelines, and in some soft substrates. Oil spills may also cause shifts in population structure, species abundance and diversity, and distribution. Habitat loss and the loss of prey items also have the potential to affect fish and wildlife populations.

**Detailed Answer:** Plant communities in coastal ecosystems have different susceptibilities to contamination. In temperate regions, salt marshes are most vulnerable. Many salt marsh plants are relatively short, measuring up to three feet in height. Because they are low, salt marsh plants can be completely covered by the oil after a spill causing dieback. This can influence the stability of the soil in wetland hammocks, causing erosion and loss of wetland habitat.

**Q: Why does it take so long for oil spills to be cleaned up along the shoreline?**

**Short Answer:** The degree of impact, and thus clean-up, will be highly dependent upon the type of shoreline that is affected. Sandy shore lines are relatively easy to clean, and the impacts from oil on the shore lines is usually not overly significant in a relative sense because the oil can be cleaned up in a reasonable timeframe once the source is stopped, and many of these types of shorelines are not as biologically active as areas such as marshes. Impacts to

coarse substrate shorelines would be more difficult to mitigate than for a fine sandy beach, simply due to the fact that the oil could penetrate further into a course substrate, and therefore cleanup efforts would have to be more extensive. It is very difficult to clean wetlands and marshes once they have been oiled. The options for cleaning the wetlands and marshes depend on a variety of factors. If the oil reaches beyond the grassy vegetation and gets to the sediments, however, options are very limited.

**Detailed Answer:**
Digging up the wetlands to remove the oil can oftentimes cause more harm than leaving the oil in place. Natural processes such as wave action to remove the oil are often not very effective, because the wetlands are usually in fairly quiescent areas which limit the amount of wave action. It should be noted that heavily oiled seagrass beds may die immediately upon contact with the oil. Seagrasses could be spared, although leaves may turn brown and become heavily covered by algae for several months. This type of impact was seen following the spill in Panama.

**Q: How will the oil spill affect the hypoxic zone in the Gulf?**

**Short Answer:** Decaying wetland plant material from oil contamination may be released into the coastal ocean. The organic materials and oxygen demand may contribute to oxygen consumption and the hypoxic zone along the continental shelf.

**Detailed Answer:** Summer is the season that the Gulf of Mexico hypoxic zone sets up, generally flowing westward from the Mississippi River plume. The phenomenon results in low dissolved oxygen in bottom waters. Coastal currents generally flow westward during winter/spring, but reverse during late spring and summer and flow eastward. The oil spill is moving towards the hypoxic zone and any decaying plant or animals resulting from the oil spill, whether in coastal waters or dead material from coastal marshes deposited by tides could exacerbate the hypoxic zone.

## Biological Impacts

**Q: How will the oil spill affect the open ocean food web?**

**Short Answer:** The phytoplankton form the base of the food web that supports marine species. Any impacts on this food base may affect the entire marine ecosystem. The impact on the phytoplankton will depend on how long the oil persists as they have short life spans, new phytoplankton can be recruited from other areas, and they move up and down in surface waters.

**Detailed Answer:**. Phytoplankton and zooplankton, critical components to the marine ecosystem, have demonstrated different reactions to oil. Larvae stages of the fish life cycle are more susceptible to acute biological loss. Fish eggs and larvae are vulnerable to oil damage in the open water environment as they float along.

**Q: What animals offshore will be affected by the oil spill?**

**Short Answer:** Any animals that have to go to the surface to breathe (turtles, whales, dolphins, and seals) and small animals such as marine birds, lantern fish (which move up to surface waters to feed at night), amphipods, jellies, invertebrate eggs and larvae may be negatively affected by the oil spill.

**Detailed Answer:** Larvae stages of the fish life cycle are more susceptible to acute biological loss. Fish eggs and larvae are vulnerable to oil damage in the open water environment as they float along. Fish can be impacted directly through uptake by the gills, ingestion of oil or oiled prey, effects on eggs and larval survival, or changes in the ecosystem that support the fish. Marine birds which spend much time on the sea surface (e.g. shearwaters, cormorants, seaducks, and alcids) are especially vulnerable to oil spills. Larger pelagic animals such as medium-sized fish and squids, may swim into the plumes and back out again. Offshore oil spills could also have a serious impact on juvenile turtles. Sea turtles and marine mammals must surface to breathe and could contact surface oil slicks. Some evidence indicates that sea turtles, especially juveniles, are transported by passive drift and are associated with density associated with density shear lines and sargassum weed. This could prolong their exposure to a large oil slick transported in the same manner. Threats to whales and dolphins are at much more risk at the surface (from inhalation of volatiles and direct contact with slicks) than they would be from diving through dispersed oil in deep water or consuming squid that may be exposed to deep water dispersed oil plumes.

**Q: Shrimp and oysters are spawning this time of year, how will the oil spill affect them?**

**Short Answer:** If the oil finds its way into the marshes, shrimp mortalities will be high. If exposed to oil, oysters will react by dedicating their energy resources to survival, rather than to reproduction.

**Detailed Answer:** Brown shrimp are now in the post-larval stage, beginning to enter the estuaries, and are vulnerable to volatile aromatic hydrocarbons, which are soluble in water. For oysters, if they do succeed in reproducing but the cultch is oiled, the spat will not set and reproductive success could be jeopardized next year and possibly beyond. Oysters also filter large volumes of water increasing exposure to the oil. The oil could persist in the marsh and open water sediments and impact aquatic organisms for quite some time.

**Q: What marine fish and invertebrate species are most likely affected by the oil spill in the Gulf?**

**Short Answer:** Pelagic fish species that migrate to the Gulf to spawn, as well as the marine fish and invertebrate species in the pelagic egg and larval stages are most likely to be affected.

**Detailed Answer:** There are many pelagic fish spp that frequent the Gulf in the spring, summer and fall. Of particular concern are those species that migrate to the gulf to spawn.

Several high value commercial and recreational pelagic (tunas, dolphinfish, cobia,) spawn in the Gulf waters. Bluefin tuna in particular may be of higher concern since spawning has been detected in only two areas: the Mediterranean and Gulf of Mexico. Little is known about the spawning of bluefin, as it has not been observed. Spawning in the Gulf of Mexico occurs from April to June. Differences in timing could be due to any of a number of factors, such as differing environmental cues or genetic variation. In the Gulf of Mexico, spawning occurs at temperatures of 76.8 to 85.1 °F(24.9 to 29.5 °C). Average females produce up to 10 million eggs per year. Their eggs are buoyant, and are distributed a considerable distance by the surface currents. Since they have buoyant eggs, this may be an issue depending on where the spawning pods are and where the oil slick is. Both chemical toxicity and physical smothering of eggs and icthyoplankton (larval fish) may occur. This type of impact is also a concern for other tuna species and other pelagic fish with this reproductive strategy. The majority (nearly all) of commercially valuable marine fish and invertebrate species, as well as the forage species they feed on, have pelagic egg and larval stages and that includes ground fish and demersal species as well as pelagics. They are all equally vulnerable to oil exposure during these early life stages.

Fortunately fish/invertebrate eggs are just marginally less dense than median seawater and a host of factors influencing the actual density of seawater, water currents, and density of eggs determines their vertical and horizontal distribution in the ocean. They are not trapped on the surface where most of the oil is concentrated. That will limit oil exposure. Larvae will move under their own power throughout the water column and also distributed according to where prey is located. They are not concentrated at the surface. Nor are they expected to be concentrated in the area of the oil spill. These assemblages are very patchy spatially both vertically and horizontally. Deepwater fish that live near the bottom (demersal) may be more likely to be at risk if small tar aggregates can settle as sea snow. The Mississippi Trough and Canyon are home to one of the most abundant and diverse communities of deep sea fishes, due to influx of nutrients from the Mississippi River. Species richness is highest on the upper slope and decreases with depth. The deep sea fishes tend not to be the commercial or recreational species.

**Q: How will oil affect the invertebrate community?**

**Short Answer:** Oil can have acute and chronic effects on inshore and offshore marine invertebrate communities when oil becomes concentrated along the shoreline causing sediments to serve as reservoirs for the spilled oil, and for pelagic species during early or adult stages when they are exposed to surface waters.

**Detailed answer:** There are both offshore marine and inshore invertebrate communities to consider. Offshore invertebrates can be exposed at the surface for those species that may be pelagic during early or adult stages. Benthic communities may be exposed as chemical dispersants and normal weathering causes oil to be deposited on the seafloor. Benthic invertebrate communities include soft (mud and sand) and hard bottom communities common in the GOM. Persistent aromatic hydrocarbons and heterocyclic compounds and their breakdown products can linger in sediments for long periods causing toxicity to marine polychaetes and other invertebrates that live in sediments.

Oil can be directly toxic to marine invertebrates or impact them through physical smothering, altering metabolic and feeding rates, and altering shell formation. These toxic effects can be both acute (lethal) and chronic (sub-lethal). Intertidal benthic (bottom dwelling) invertebrates may be especially vulnerable when oil becomes highly concentrated along the shoreline. Additionally, sediments can become reservoirs for the spilled petroleum. Some benthic invertebrates can survive exposure, but may accumulate high levels of contaminants in their bodies that can be passed on to predators. The coastal subtidal zone (underwater at all times) and intertidal zone (covered only during high tide) are inhabited by multiple small invertebrates. The fiddler crab, a species that inhabits the intertidal zone, is regarded as the "canary in a coal mine" for oil spills. This invertebrate is present in the estuarine habitats around the world and is therefore a universal indicator for the impact of oil spills on coastal ecosystems. As with other organisms, fiddler crabs exhibit dose response mortality due to oil toxicity. Thus the status of the fiddler crab population in an area after an oil spill is a sensitive marker for the severity of the spill.

**Q: What are the possible effects of the crude oil on the fish community?**

**Short Answer:** Fish can be impacted directly through uptake by the gills, ingestion of oil or oiled prey, effects on eggs and larval survival, or through changes in the ecosystem that support the fish.

**Detailed Answer**: Adult fish may experience reduced growth, enlarged livers, changes in heart and respiration rates, fin erosion, and reproductive impairment when exposed to oil. Fish exposed to sublethal concentrations can display elevated liver enzymes involved in detoxification. Destruction of the estuarine and marsh habitat used for spawning and nursery grounds may have a big impact on both inland and offshore fish communities. Oil has the potential to impact spawning success, as eggs and larvae of many fish species, are highly sensitive to the toxic constituents of crude oil.

## Marine Mammals

**Q: What affects will the oil spill have on whales, dolphins, and seals (marine mammals)?**

**Short Answer:** Marine mammals are at much more risk at the surface (from inhalation of volatiles and direct contact with slicks) than they would be from diving through dispersed oil in deep water.

**Detailed Answer:** Fresh crude oil releases toxic vapors that when inhaled may irritate or damage respiratory membranes, congest lungs, and cause pneumonia. Following inhalation, volatile hydrocarbons may be absorbed into the bloodstream and accumulate in the brain and liver, leading to neurological disorders and liver damage (Geraci and St. Aubin, 1982; Geraci, 1990). Toxic vapor concentrations may occur just above the surface of an oil spill and, thus, may be available for inhalation by surfacing cetaceans. For whale and dolphins (and probably sirenians as well), direct contact of oil may irritate, inflame, or damage skin and sensitive

tissues (such as eyes and other mucous membranes). Prolonged contact to petroleum products may reduce food intake; elicit agitated behavior; alter blood parameters, respiration rates, and gas exchange; and depress nervous functions. Under less extreme exposures (lower concentrations or shorter durations), oil does not appear to readily adhere to or be absorbed through cetacean skin, and may actually provide a barrier to the uptake of oil-related aromatic hydrocarbons through the body surface. The most likely effects of oil on marine mammals are: (a) a mild deleterious but reversible effect on the skin; (b) possible eye irritation, which would be reversible unless exposure is prolonged; (c) possible short-term baleen fouling with possible feeding reduction; (d) possible blowhole fouling and death due to respiratory stress for very young animal in heavy oil; and temporary food reduction or contamination, and oil ingestion.

**Q: What if marine mammals consume food that is contaminated with oil?**

**Short Answer:** Marine mammals may incidentally ingest floating or submerged oil or tar and may consume oil-contaminated prey. Ingested oil can remain within the gastrointestinal tract and be absorbed into the bloodstream.

**Detailed Answer:** Marine mammals may incidentally ingest floating or submerged oil or tar and may consume oil-contaminated prey. Spilled oil may also foul the baleen fibers of mysticete whales, temporarily impairing food-gathering efficiency or resulting in the ingestion of oil or oil-contaminated prey. Ingested oil can remain within the gastrointestinal tract and be absorbed into the bloodstream and, thus, could irritate and/or destroy epithelial cells in the stomach and intestine. Certain constituents of oil, such as aromatic hydrocarbons and polyaromatic hydrocarbons, include some well-known carcinogens. These substances, however, do not show significant biomagnification in food chains and are readily metabolized by many organisms.

## Marine and Coastal Birds

**Q: How will the oil slick affect marine and coastal birds?**

**Short Answer:** Marine birds which spend much time on the sea surface are especially vulnerable to oil spills. Birds may be adversely affected through direct contact with the spilled oil, by the fouling of their habitats and contamination of their food by the oil, and as a result of oil-spill response activities.
Direct contact by birds with oil of appreciable amounts is usually fatal. Diving birds and underwater swimmers such as loons, cormorants, and diving ducks may be the most susceptible to spilled oil because of their relatively long exposure time in the water and at the sea surface. Also, many of these birds nest and roost on barrier islands and beaches and are at risk if oil comes ashore or affects their food sources.

**Detailed Answer:** Birds may become fouled with oil by diving through oil slicks to capture prey, or by wading and walking through contaminated areas, then preening feathers and ingesting the oil. Mortality results primarily from hypothermia as oil mats the plumage

destroying the thermal barrier. Ingested oil may depress egg laying activity or may result in the death or deformities of young coastal birds. Additionally, abnormalities in bird reproduction physiology and behavior resulting from ingestion of oil potentially could have substantial adverse effects on egg production in seabird and water fowl populations.
Some species have begun nesting or building pair bonds in preparation for nesting. Many exhibit low reproductive rates and a disruption to their breeding cycle this year could have serious effects on the population for years to come. They feed on fish and other estuarine organisms, such as small invertebrates or oysters. If these food sources become contaminated, lethal and sublethal toxic and physiological effects or starvation from the reduction of food resources could occur. Finally, oil-spill response activities may disturb birds in the affected habitat as well as nearby habitats that are unaffected by an oil spill.

## Threatened or Endangered Species

**Q: What threatened or endangered species are in the Gulf region?**

**Short Answer:** Some endangered species in the Gulf region include whales, fish, turtles, and coastal and marine birds.

**Detailed Answer:** The West Indian manatee, five baleen whales (the northern right, blue, fin, sei,and humpback), one toothed whale (the sperm whale), Gulf sturgeon, Smalltooth Sawfish, Dusky, Night and Tiger Sharks, Nassau and Warsaw Grouper, and five species of sea turtles (the Green, Hawksbill, Kemp's Ridley, Leatherback, and Loggerhead) are some of the endangered species at risk in this oil spill.

**Q: How will the oil spill affect sea turtles?**

**Short Answer:** The oil spill can have a serious impact on sea turtles as the turtle surfaces to breathe and as the oil spill goes ashore on the sandy beaches the turtles use to deposit their eggs in. A large spill could affect many more individuals and habitats, including nesting beaches, and potentially may incur population-level effects.

**Detailed Answer:** Hatchling and juvenile turtles feed opportunistically at or near the surface in oceanic waters, and may be especially vulnerable and sensitive to spilled oil and oil residues such as floating tar. Some evidence indicates that sea turtles, especially juveniles, are transported by passive drift and are associated with density associated with density shear lines and sargassum weed. This could prolong their exposure to a large oil slick transported in the same manner.
Ingested oil, particularly the lighter fractions, could be toxic to sea turtles. Ingested oil may remain within the gastrointestinal tract, irritate and/or destroy epithelial cells in the stomach and intestine, and subsequently be absorbed into the bloodstream (NOAA, 2003). Certain constituents of oil, such as aromatic hydrocarbons and PAHs, include some well-known carcinogens. Sea turtles and marine mammals must surface to breathe and could contact surface oil slicks inhaling petroleum vapors and aspirating small quantities of oil. While no

information is available regarding the effects of petroleum vapors or aspirated oil on sea turtles, inhalations by mammals of small amounts of oil or petroleum vapors have been shown to result in acute fatal pneumonia, absorption of hydrocarbons in organs and other tissues, and damage to the brain and central nervous system. Tar found in the mouths of turtles may have been selectively eaten or ingested accidentally while feeding on organisms or vegetation bound by tar. Sea turtles exposed to oil or tar balls have been reported to incur a variety of conditions, including inflammatory dermatitis, breathing disturbance, salt gland dysfunction or failure, hematological disturbances, impaired immune responses, and digestive disorders or blockages.

Because most sea turtles nest above the high-tide line, and oil washing ashore would be deposited at and just above the high-tide line, oiling of actual nests is unlikely except possibly in the event of exceptionally high tides or storms. However, hatchlings may become oiled while traveling from the nest to water, and a heavy oil layer or tar deposits on the beach may prevent the hatchlings from reaching water. If exposed hatchlings reach the water, they may have difficulty swimming, increasing the potential for predation. Nesting adults (females) may also be exposed while coming ashore on oiled beaches. Impacts on the quality or quantity of foraging or nesting habitats could result in population level effects.

The magnitude and severity of impacts that could result from such exposures would depend on the location of the spill, spill size, type of product spilled, weather conditions, the water quality and environmental conditions at the time of the spill, and the species and life stage of the sea turtle exposed to the spill.

**Q: Will the oil spill affect manatees?**

**Short Answer:** The West Indian manatee would be most vulnerable to a spill as it occurs in marine, estuarine, and freshwater river systems and canals where it congregates.

**Detailed Answer:**

The West Indian manatee range freely between marine and freshwater habitats along coastal Florida, Alabama, Mississippi, Louisiana, and Texas, and, therefore, could be exposed to the oil spill. They eat both submerged (e.g. seagrass) and floating vegetation and could be impacted if these food sources are contaminated or large stands of seagrass die from oil exposure. Impacts to the manatee population could be significant due to population decreases from the cold winter in Florida.

## Wetlands

### Wetland Impacts from Oil Spill
### Questions and Answers

**Q: How will oil affect the wetland region of the Gulf and why are people concerned?**

**Short Answer:** Oil spills may cause shifts in wildlife and plant population structures, species abundance, diversity and distribution, as well as erosion and loss of wetland habitats resulting

from possible dieback of salt marsh plants. Southern Louisiana contains 40% of the wetlands found in the lower 48 states. The bays and estuaries are the nursery grounds for numerous fish and shrimp species. In fact, 90% of the marine fish and shellfish are estuarine-dependent. The greatest concern is for these critical shallow water habitats. The seafood production from the Gulf of Mexico exceeds that of all the areas of the east coast from Maine to Florida, combined. Louisiana accounts for almost 80% of that Gulf production. Recreational fishing pumps billions of dollars into regional economies each year (Louisiana - $757 million).
**Detailed Answe**r: Habitat loss has the potential to affect fish and wildlife populations. Oil remains in the environment long after a spill event, especially in areas sheltered from weathering processes, such as the subsurface sediments under gravel shorelines, and in some soft substrates. Plant communities in coastal ecosystems have different susceptibilities to contamination. In temperate regions, salt marshes are most vulnerable. Many salt marsh plants are relatively short, measuring up to three feet in height. Because they are low, salt marsh plants can be completely covered by the oil after a spill causing dieback. This can influence the stability of the soil in wetland hammocks, causing erosion and loss of wetland habitat.

Aquatic organisms that feed on detritus in shallow coastal waters, such as shrimp, blue crabs and filter feeders such as mussels and oysters, could be impacted by exposure to small particles of tar suspended in the water column and sinking to the bottom. Wildlife inhabiting coastal marshes can become exposed to contamination accumulating in their food supply. Wading birds, such as herons, egrets, ibis, clapper rails, and wood storks, and mammals such as raccoons could become exposed to oil-related polycyclic aromatic compounds through the foodchain.

The coastal wetland ecosystem not only produces seafood but provides natural filtration, and cleanses water of pollution and contaminants. These wetlands protect our coastal communities from natural disasters. Every mile of wetlands can reduce storm surge by as much as a foot. That means billions saved in lost property. All these valuable contributions to our health and well being are at risk by what could be one of the most significant oil spills ever in our coastal waters.

**Q. What will be the impacts of the Deepwater Horizon spill to the coastal wetlands and what factors influence those impacts?**

**Short Answer:** We cannot predict the specific impacts with certainty because it is unknown as to where the oil spill will come ashore, but we do have a basic understanding of the potential effects that oil can have on wetland plants and soils. Critical to better understanding the impact of the oil spill on wetlands will be knowledge of the following: 1) type of oil, 2) direction oil spill is headed and projected landfall, 3) wetland types projected to be impacted by oil spill, and 4) wetland plant species sensitivity to oil contamination.
**Detailed Answer:** There is considerable uncertainty about the present and future quantities of oil released, the actual make up of the oil, its anticipated trajectory of impact, the effect of projected use of deep water dispersants, and future meteorological conditions. Anticipated outcomes could change dramatically as new data becomes available. Because the oil is being released such a distance from shore and at such depth, it is anticipated that the oil will undergo significant weathering before reaching shoreline areas. Sea conditions will weather the oil, as the more water soluble compounds tend to be "extracted" from the oil, leaving the less soluble and more viscous compounds to continue to coalesce on the water surface.

The level of impact to coastal wetlands by oil is influenced by a number of factors, including: 1) type (i.e., toxicity and viscosity properties) and amount of oil, 2) plant species' sensitivity, 3) extent of oil coverage on vegetation and marsh surface, 4) season of the spill, 5) weather conditions, and 6) soil composition (i.e., soil organic matter influences penetration and sorption of oil; soils with high soil organic matter may be of particular concern; soil texture can also potentially affect residual oil concentrations). Increasing our understanding of these various factors will help us to better anticipate what coastal wetland impacts can be expected.

**Q: Where are the areas being impacted, how will those different wetland/shoreline types be impacted and what are the clean up options?**

**Short Answer:** Although it is difficult to identify the exact locations where the oil will come ashore, there are very large expanses of marshes in the Pass A Loutre Wildlife Management Area and the Delta National Wildlife Area in the eastern portion of the Mississippi River Delta of Louisiana that appear to be in the path of a oil spill landfall. We also know that should it reach the Mississippi River Gulf Outlet, this could provide the oil spill ingress to additional expanses of those marsh habitats, both emergent scrub-shrub, and forested wetlands. The degree of impact will be highly dependent upon the type of shoreline or marsh physiography and substrate that is affected. The following are examples of different wetland and shoreline types, their sensitivity to oil spills and potential clean-up scenarios. Options for cleaning or removing oil from wetlands areas are very limited. It is possible, depending on the type of oil and potential for other environmental effects, that the best option would be to allow for the natural attenuation of the oil. The goal should be to minimize damage from the cleanup effort itself. Too many people and machines mucking about could seriously compound the damage. The rule of thumb should be to place top priority on maintaining the physical and chemical integrity of the habitat, so the organisms will have an opportunity to repopulate. Treat the marshes gently.

**Detailed Answer:** Potentially, other areas of Louisiana including the Chandeleur Islands within the Breton National Wildlife Refuge, Breton Sound, Chandeleur Sound, and the highly fragmented marshes of Plaquemines and St. Bernard Parishes may also be affected. In addition for Mississippi, once in Breton Sound, oil could move into Mississippi Sound and onto western Mississippi barrier islands and shorelines. Oil could also move in a westerly direction into Lake Borgne and Lake Pontchartrain, due to the broken marsh topography, expanse of open water, and meteorological influences. There are also areas of coastal Mississippi, Alabama, and the panhandle of Florida that could be affected, including marshes and possibly mangroves.

Wetlands are fairly fragile and very biologically active habitats, therefore the physical effects of fouling and coating of these environments are expected to be significant. It is very difficult to clean wetlands once they have been oiled. The options for cleaning the wetlands depend on a variety of factors. If the oil reaches beyond the grassy vegetation and gets to the sediments, however, options are very limited. Digging up the wetlands to remove the oil can oftentimes cause more harm than leaving the oil in place. Natural processes such as wave action to remove the oil are often not very effective, because the wetlands are usually in fairly quiescent areas which limit the amount of wave action. It should be noted that heavily oiled sea grass beds may die immediately upon contact with the oil and entire intertidal beds of sea grasses may be killed. Sub-tidal sea grasses could be spared, although leaves may turn brown and become heavily covered by algae for several months.

Marsh plants may survive being oiled, unless the majority of the plant is covered, including roots and stems. If incident response personnel are walking or moving equipment throughout the marshes, compacting the substrate and uprooting plants, holes could open up where open water could replace marsh. To the degree possible, it would be advantageous to restrict response vehicles, equipment, and personnel to established waterways. Consideration should be give to placing booms outside of the marsh edges. If oil floods further into the marsh, attempts could be made to skim or absorb oil on the ebb, or outgoing, tide.

These specific wetland/marsh types can be found along the area of potential impact:

**Sandy Tidal Flats**
The sandy tidal flat classification is used to describe shoreline types comprised of broad intertidal areas consisting of fine and coarse grain sand and minor amounts of shell hash. The mean grain size ranges between 0.0625 mm and 0.4 mm. Sandy tidal flats are typically found in association with barrier island and tidal inlet systems. Sandy tidal flats are submerged during each tidal cycle. At low tide, a typical sandy tidal flat may be 100-200 m wide. The most common sandy tidal flat occurrences are associated with flood-tidal deltas, recurved spits, and back barrier areas. Salt marsh vegetation often develops along the upper intertidal areas of sand flats. Due to the low tidal flat gradient, slight changes in water levels can produce significant shoreline changes. Low water levels can expose extensive tidal flat areas to oiling.

**Sandy Tidal Flats Environmental Concerns**

- **Sensitivity:** The environmental sensitivity of sandy tidal flats is moderate due to the presence of wetland habitat.

- **Oil Behavior:** Oil typically stains and covers sediment and vegetation with low to moderate sediment penetration.
- **Cleanup:** The oil penetration potential is low/moderate depending on the water level and the location of oil deposition. The transitability of sandy tidal flats is moderate/good depending on substrate character. Major environmental concerns related to cleanup include the protection and cleanup of wetland habitat and further subsurface contamination due to trampling and equipment movement. Tidal flat access in Louisiana is typically poor.

**Muddy Tidal Flat**

The muddy tidal flat classification is used to describe shoreline types comprised of broad intertidal areas consisting of mud and minor amounts of shell hash. The grain size is finer than 0.0625 mm. Muddy tidal flats are typically found in association with prograding river mouths. Muddy tidal flats are soft, dynamic shorelines rich in newly developing habitat. Mudflats located at prograding river mouths are vegetated by willow tree and sugar cane swamps. Prograding mudflats on the coast are vegetated by lush growths of salt marsh.

**Muddy Tidal Flats Environmental Concerns**

- **Sensitivity:** The environmental sensitivity of muddy tidal flats is high due to presence of developing wetland habitat. Oil usually coats and covers sediment and vegetation.
- **Oil Behavior:** Oil typically stains and covers sediment and vegetation.
- **Cleanup:** The sediment penetration potential is low due to the high water table and water content in the sediment. The major environmental concern associated with muddy tidal flats is the damage done by the cleanup of wetland habitats as well as their protection from cleanup operations. Both access and transitability of muddy tidal flats is poor. The potential exists for further contamination of subsurface sediments due to trampling and equipment movement.

**Swamps**

The swamp classification describes shoreline types that are comprised of scrubs, shrubs, evergreen trees, and hardwood forested wetlands. This shoreline type is essentially a flooded forest. This shoreline type is common in the river valleys of the chenier plain, and the interior areas of the delta plain. The sediments within the interior swamps tend to be silty clay and contain a large amount of organic debris.

**Swamps Environmental Concerns**

- **Sensitivity:** The environmental sensitivity is high for swamps because of the presence of wetland habitat.
- **Oil Behavior:** Oil usually coats and covers the sediment and vegetation with low sediment penetration.
- **Cleanup:** The sediment penetration potential is low due to the high water table and the water content of the sediments. A major environmental concern is that the cleanup may

be more damaging than the oil itself. The access and trafficability of swamps are poor due to the soft sediment and the presence of dense tree growth.

**Fresh Marshes**

The fresh marsh classification is used to describe shoreline types found in the coastal interior. Freshwater marshes include floating aquatic mats, vascular submerged vegetation, needle and broad-leaved deciduous scrubs and shrubs, and broad-leaved evergreen scrubs and shrubs. The sediments are highly organic and muddy. Fresh marshes are characterized by high biodiversity and rich wetland habitat. This shoreline type is found within the river valleys that dissect the chenier plain as well as between the individual ridges. On the delta plain, freshwater marshes occur in the upper reaches of individual delta complexes as well as along distributary courses.

**Fresh Marsh Environmental Concerns**

- **Sensitivity**: The environmental sensitivity of fresh marshes is high because of the presence of wetland habitat.
- **Oil Behavior:** Oil usually coats and covers the sediment and vegetation with low sediment penetration.
- **Cleanup:** The sediment penetration potential is low due to the high water table and water content of the sediments. A major environmental concern about fresh marsh is that the cleanup can be more damaging than the oil itself, left alone. Transitability of fresh marsh is poor due to the soft sediment. Access is typically poor in Louisiana.

**Salt Marshes**

The saltwater marsh classification describes shoreline types that are wet grasslands vegetated by salt-tolerant species. This shoreline type includes saline, brackish, and intermediate marsh types. Saltwater marshes are extensive throughout the outer fringe of the Chenier and delta plains.

**Salt Marsh Environmental Concerns**

- **Sensitivity:** The environmental sensitivity is high for salt marsh because of the presence of wetland habitat.
- **Oil Behavior:** Oil usually coats and covers the sediment and vegetation with low sediment penetration.
- **Cleanup:** The sediment penetration potential is low/moderate due to the high water table and water content of the sediment. A major environmental concern is that the cleanup may be more damaging than the oil itself. The transitability of salt marsh is poor. Access is typically poor in Louisiana.

**Q: How will the oil spill impact marsh plants, mangroves, or other wetland aquatic plants?**

**Short Answer:** The tarry residue that will make it to shore lines will likely cover whatever it touches and can cause smothering of wetlands and marshes.

**Detailed Answer:** The greatest negative impact to wetlands/marshes/swamps is anticipated to occur for marsh plants and mangrove shorelines. Petroleum hydrocarbons impact plants in several ways including disruption of plant-water relationships, direct impacts to plant metabolism (e.g. nutrient uptake), toxicity to living cell (e.g. chloroplast membrane), and reducing oxygen exchange between atmosphere and soil (impact root function). Although much of the lighter and more water soluble fraction of the oil is anticipated to have been weathered from the land-falling crude, which should ameliorate the chemical toxicity hazards somewhat, the weathered crude is likely to coat whatever it touches. Species sensitivity maybe related to the effect of oil on photosynthetic rate, live and dead biomass, plant-stem density, plant re-growth year after spill. One of the primary reasons for plant dieback is a result of death of underground rhizomes. Deeper penetration of oil could result in higher mortality of plants. *Spartina patens* are shallow rooted species and are more susceptible to subsurface oil contamination.

**Q: What are the impacts of oil penetrating soils and sediments?**

**Short Answer:** The penetration of oil into the soil/sediments has the potential to cause acute and chronic plant damage. The deeper penetration of oil could result in higher mortality of plants.
**Detailed Answer:** Acute and chronic plant damage can include reduced stem height, reduced plant density, reduced aboveground biomass, and mortality. If the oil impacting the wetlands is relatively thick oil, it could cause physical smothering of the sediments, sediment dwelling organisms including eggs that have been laid, and the wetland plants.

**Q: How will beaches be impacted?**

**Short Answer:** The degree of impact on beaches resulting from the oil spill will be highly dependent upon the grain size of the beach substrate.
**Detailed Answer:** Traditionally, sandy shore lines are relatively easy to clean, and the impacts from oil on the shore lines is usually not overly significant in a relative sense because the oil can be cleaned up in a reasonable timeframe once the source is stopped, and many of these types of shorelines are not as biologically active as areas such as marshes. Shore lines with coarser substrate such as gravel or cobble also are able to be cleaned to a large degree, and therefore the impact of the shorelines are not anticipated to be exceptionally long-lived once the source of the oil has been stopped. Impacts to coarse substrate shorelines would be more difficult to mitigate than for a fine sandy beach, simply due to the fact that the oil could penetrate further into a course substrate, and therefore cleanup efforts would have to be more extensive.

**Q: Can dispersants be used in wetland areas?**

**Short Answer:** The use of dispersants offshore will lessen the potential impact of the oil onshore, however it may increase the risk for water column toxicity in the areas where the dispersants are being used.
**Detailed Answer:** Generally, dispersants are used in deeper waters, which allow aquatic life the opportunity to flee from the plume of dispersed compounds. Using dispersants in shallow

water can exacerbate some of the aquatic toxicity of the spilled oil (e.g., it solubilizes chemicals contained in the oil) and therefore they are not often recommended for use in shallow waters. Estuarine use of dispersals must be approved by the Regional Response Team.

Dispersants have been pre-approved for use in ten meters of water or deeper. Much of the targeted Louisiana estuarine area is significantly shallower than that, with less wave energy than situations in which dispersants have previously been employed.

In order to be effective, dispersants require energy, such as wave energy, to mix them through the oiled surface waters. Breaking the oil into droplets increases the surface area and facilitates the biodegradation of the hydrocarbons. In extremely shallow nearshore environments along the Gulf coast, adequate mixing energy may be lacking. Oil dispersants have been proven in deeper, higher energy marine environments but could "disperse" or transport oil throughout a vastly broader area and into more ecologically sensitive areas of the delta and nearby bays. Dispersants may not be completely benign in an estuarine environment. They might prove to be toxic or at least act as an ecological stressor to oysters, shrimp, and larval fish in the intertidal zone. This might be all the more significant during the spring spawning season.

**Q: Is chemical toxicity a concern for wetlands?**

**Short Answer:** Again, some chemical toxicity would be expected, but the main effect would likely be a physical smothering. This physical smothering and coating effect would be both for the plants and aquatic/semi-aquatic animals, as well as for any animals such as birds or mammals that come into contact with the oil in the marshes.

**Q: What are the potential long term impacts of the oil spill on wetlands and will they be able to recover?**

**Short Answer:** The long term- potential for reduced growth and inhibited recovery are a function of the spill intensity, type of oil, concentration of oil, species affected, degree of plant cover, persistence of oil, extent of soil penetration and season of contamination. Due to the difficulty in identifying the specific impacts and the extent of those impacts, it is also difficult to determine the resiliency of these wetlands in being able to recover from oil contamination. Wetlands and marshes are fairly fragile and very biologically active habitats; therefore, the physical effects of fouling and coating of these environments are expected to be significant.
**Detailed Answer:** Any additional stress from the Deepwater Horizon oil release could be devastating to these resources and serve as a tipping point to the sustainability of the coastal landscape. The Mississippi deltaic plain is experiencing some of the highest historic rates of coastal wetland loss in the country and in the world. Coastal wetland loss has been widespread in Louisiana over the past century and an historic average of 25-30 square miles of land was lost per year from 1978-2000 (Barras *et al*. 2003). Current trends point to an additional loss of approximately 1300 $km^2$ by 2050. This region experienced yet another spike in wetland loss and degradation as a result of major hurricanes over the last few years. However, the vast expanse of the existing productive wetland ecosystem still represents a significant regional and national asset. The ecological and associated economic impacts could easily have national ramifications.

Although, the long term impacts on wetlands may not be well documented, the reason being that it is often difficult to separate the effect of oil spill on marsh deterioration from ambient rates of deterioration. What we do know is that the long term- potential for reduced growth and inhibited recovery are a function of the spill intensity, type of oil, concentration of oil, species affected, degree of plant cover, persistence of oil, extent of soil penetration and season of contamination. Oil penetration into the soil/sediments has the potential to cause immediate and long term affects to the wetland and wetland plant species. Wetland plant damage could be realized in reduced stem height, reduced plant density, reduced aboveground biomass and slow vegetative recovery. Slow vegetative recovery can have significant ecological impacts, such as, the impact of increasing the wetlands/marsh vulnerability to erosion and loss. Plant sensitivity and vulnerability to oil contamination can vary. For example, if we compare three common *Spartina spp*. that are found in the Gulf Coast region (*S. patens, S. alterniflora*, and *S. lancifolia*) oil contamination may affect the plants to differing degrees. The shoots of *S. patens* and *S. alterniflora* are not resistant to oil contamination and the rhizomes small and shallow. Oiling of these species can reduce their ability to photosynthesize making them susceptible to mortality. Whereas, *S. lancifolia* impacts maybe less devastating possibly due to larger rhizomes and oil resistant shoots.